

DOCUMENT RESUME

ED 235 040

SE 043 333

AUTHOR Jones, Natalie; Hughes, Wyn
 TITLE Housing. Third World Science.
 INSTITUTION University Coll. of North Wales, Bangor (United Kingdom). School of Education.
 SPONS AGENCY Training Services Agency, London (England).
 PUB DATE 82
 NOTE 38p.
 AVAILABLE FROM The Centre for World Development Education, 128 Buckingham Palace Road, London SW1W 9SH.
 PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)
 EDRS PRICE MF01/PC02 Plus Postage.
 DESCRIPTORS *Building Design; *Building Plans; Cultural Activities; *Developing Nations; Elementary School Science; Foreign Countries; *Housing; Intermediate Grades; Models; Science Activities; Science Education; *Scientific Concepts; Secondary Education; *Secondary School Science
 IDENTIFIERS Africa; Sri Lanka; *Third World Science Project; United Kingdom

ABSTRACT

This unit, developed by the Third World Science Project, is designed to add a multicultural element to existing science syllabi (for students aged 11-16) in the United Kingdom. The project seeks to develop an appreciation of the: boundless fascination of the natural world; knowledge, skills, and expertise possessed by men/women everywhere; application of knowledge and skills to solve the practical problems of everyday life; impact of modern technology in the world; and the influence of the cultural background on the perception of knowledge, problems, and solutions. The unit begins with a brief survey of rural, traditional building and associated problems, using Datoyili (Northern Ghana) as an example of a loosely nucleated settlement of single-story huts. A plan of the village, chief's compound, and interior of chief's hut are included. Scientific concepts involved in building are then considered, such as advantages of cylindrical huts related to direction of sun's rays and use of the thatched roof as non-conductor of heat. Mathematical exercises related to these topics are included. Additional sections focus on construction/comparison of round/rectangular houses, importance of using local labor/materials in constructing houses, and other topics. The unit concludes with illustrated instructions for making models of round huts and rectangular dwelling. (JN)

 * Reproductions supplied by EDRS are the best that can be made *
 * from the original document. *

third world science

ED235040

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☒ This document has been reproduced as
received from the person or organization
originating it.
☐ Minor changes have been made to improve
reproduction quality.

• Points of view or opinions stated in this docu-
ment do not necessarily represent official NIE
position or policy.



"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

Lolo Wyn Williams

HOUSING

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."



SE043333

THIRD WORLD SCIENCE

Third World Science seeks to develop an appreciation of:

- 1 The boundless fascination of the natural world
- 2 The knowledge, skills and expertise possessed by men and women everywhere
- 3 The application of knowledge, skills and expertise to solve the practical problems of everyday life
- 4 The impact of modern technology in the third world
- 5 The influence of the cultural background on the perception of knowledge, problems and solutions

The following Units have been designed to fit into existing science syllabuses in the United Kingdom:

CARRYING LOADS ON HEADS: CHARCOAL: CLAY POTS:
DENTAL CARE: DISTILLATION: ENERGY CONVERTORS:
FERMENTATION: HOUSING: IRON SMELTING: METHANE DIGESTORS:
NATURAL DYES: PLANTS AND MEDICINES: SALT: SOAP.

The method of use is not closely prescribed. As resources teachers may use them in different ways though suggestions are offered. Feedback is invited from teachers concerning (a) the use made of the material (b) pupils reactions, if possible in their own words, and (c) suggestions for improvements, additions etc.

Please send feedback, ideas and requests to:

Professor Iolo Wyn Williams
Third World Science Project
School of Education
University College of North Wales
BANGOR
Gwynedd, U.K.
Tel: 0248-51151

Copyright: Third World Science Project 1982



HOUSING

Teacher's Notes

The unit begins with brief survey of rural, traditional building and associated problems. Datoyili - a Savanna village in Northern Ghana is taken as an example of a loosely nucleated settlement of single storey huts. A plan of the village, chief's compound and the interior of the chief's hut are included.

Sections 4-8 inclusive are intended to stress the scientific concepts involved in building e.g. advantages of a cylindrical hut in relation to direction of sun's rays, the thatched roof as a non-conductor of heat etc. We have included some simple mathematical exercises to compare areas etc. of round and rectangular huts.

This is followed by a contribution by third year pupils of Lubushi Seminary in Northern Zambia, and they describe the construction of a typical traditional round hut and compare it with more modern rectangular house.

An extract from the Intermediate Technology leaflet on Housing has been included to emphasise the importance of using local materials and local labour to build the most suitable type of dwelling to meet the needs of the local people. The Intermediate Building Technology Project in Sri Lanka follows briefly and stresses that if the few deficiencies in traditional building could be improved, then substantial improvements to the overall quality of housing could be achieved.

The unit concludes with an illustrated instruction guide on how to make models of a typical round hut (rontabole) and a rectangular dwelling (ntlo).

HOUSING

Contents

Page

1. Introduction to Housing - traditional building and associated problems	1
2. Map of Ghana	3
3. Housing in Tropical Africa - taking Datoyili as a typical example	4
Plan of Datoyili	5
Plan of Chief's Compound	6
Interior of Chief's Hut	8
4. Advantages of Round Houses	9
5. Which House is cooler to live in?	10
6. Which Shape is more convenient?	11
7. Different roof shapes and comparison of roof areas	12
8. Comparison of the internal volumes of the roofs	13
9. Contribution from pupils of Lubushi Seminary, Zambia	14
10. Extract from Intermediate Technology leaflet - Housing	19
11. Extract from Intermediate Technology Project in Sri Lanka	21
12. Pupil Activities - two models to make	25
13. Illustrated instruction guide	29
14. References	32

Introduction to Housing

Throughout the world, rural building has traditionally made use of locally abundant materials: stone and soil for walls, and sometimes for roofs too; timber to provide structural frames, roof supports and many other uses; reeds, palm leaves, and grasses for thatch, mats and partitions. According to which of these building materials was available, a fascinating variety of building types has been invented in response to local climate and the needs of society.

But these traditional building types have some common problems. Vegetable materials decay rapidly, especially in tropical conditions, and soils are eroded by heavy rainfall. Consequently many traditional building types have a short life and are liable to leak. They also tend to harbour insects and vermin, and therefore to be unhealthy. Buildings of soil are liable to collapse in earthquakes, and this commonly causes huge loss of life. Vegetable materials easily catch fire.

These problems are enormously increased when traditional buildings are built in urban areas where the pattern of employment leaves little time for regular rebuilding, where the materials for rebuilding are less easily available, and where crowding and poor sanitation increases the risk of disease through unhealthy accommodation. Thus, picturesque as they may be, the traditional building types are inevitably giving way to stronger, more durable buildings adapted for the new patterns of living, whether in the rural or urban areas.

This process - of gradual replacement of buildings and advance in building technology - has been continuous throughout the world. But recently, in many developing countries, a new stage has been reached. Factory-made building materials, originally developed in the industrialised countries for their own need, have recently become available - galvanised steel sheets for roofing, cement for mortars and plaster, steel for reinforcement, glass for windows etc.

At first these materials were imported from industrialised countries, but more recently factories for producing them have been established in many developing countries. Because of their vastly superior strength and durability, these materials have become the preferred materials for all types of building, and their use has spread rapidly. But they too have their problems.

The first problem is that they are costly; costly to produce and costly also to transport from factories to distant building sites. So it is only the better off and those nearer the factories - in the towns - who have been able

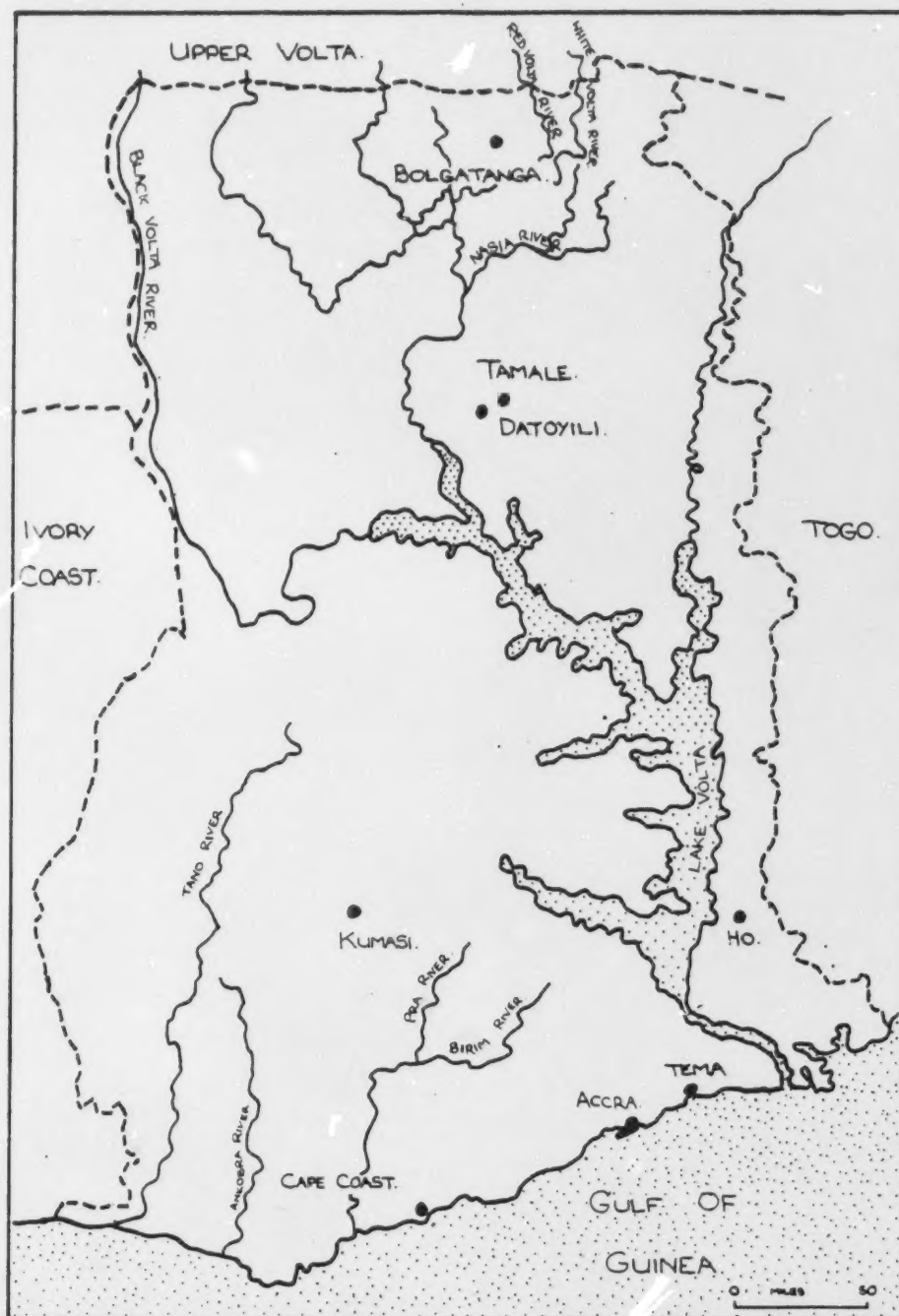
to use them. Improvements in building have been concentrated in the towns - and the gap in living standards between the better-off city dwellers and the poorer rural people has been increased further.

The second problem is that the climatic protection given by buildings made of these new materials is frequently inferior to that given by the traditional local materials. For example, corrugated steel roof sheets provide only a fraction of the protection from the heat of the sun given by traditional thatch roofs. These defects in performance can usually be overcome by better design - but only by making the new materials still more expensive to use.

So there is need for a different approach, for what has been called an 'intermediate technology' in building. Such a technology would provide a means of satisfying the developing needs and aspirations of people for better types of buildings, in a way which all could afford, and not just a small privileged group. It would start by making use of local materials exclusively, and of methods of processing these materials which are cheap and can be learned easily; it must respect the traditional patterns of building in the area, both in their response to the climate and to existing ways of living, and not attempt to copy imported styles and values. And, since governments everywhere are unable to provide enough money for all the building needs of their citizens, it must allow for people to participate in the planning and construction of their own buildings.

There are many people all over the world who are aware of these problems and are trying to develop an appropriate building technology for their own conditions.

GHANA

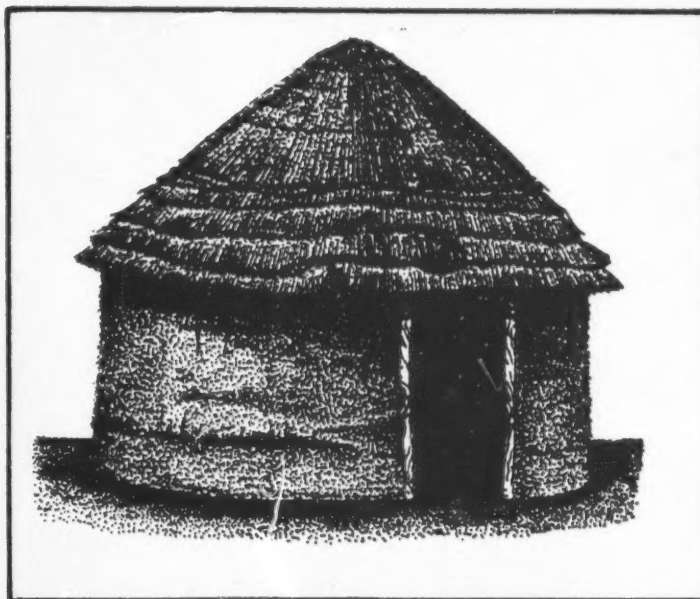


HOUSING IN TROPICAL AFRICA

Throughout tropical Africa you will see two basic styles of houses, a round hut or a rectangular building. Each of these types have advantages and disadvantages over one another.

Datoyili is a Savanna village situated in Northern Ghana - 6 miles to the south west of Tamale (See Map). The village is in an area of Guinea-savanna-woodland, composed of short trees, often widely spaced, with a more or less continuous carpet of grass. Many of the trees are fire resistant and have thick bark. Trees like the baobab and the shea are well adapted to withstand the long drought and strong winds for their shiny or hairy leaves present only a thin edge to the wind.

Datoyili is a loosely nucleated settlement composed of single storey huts, the majority of which are round though some are rectangular.

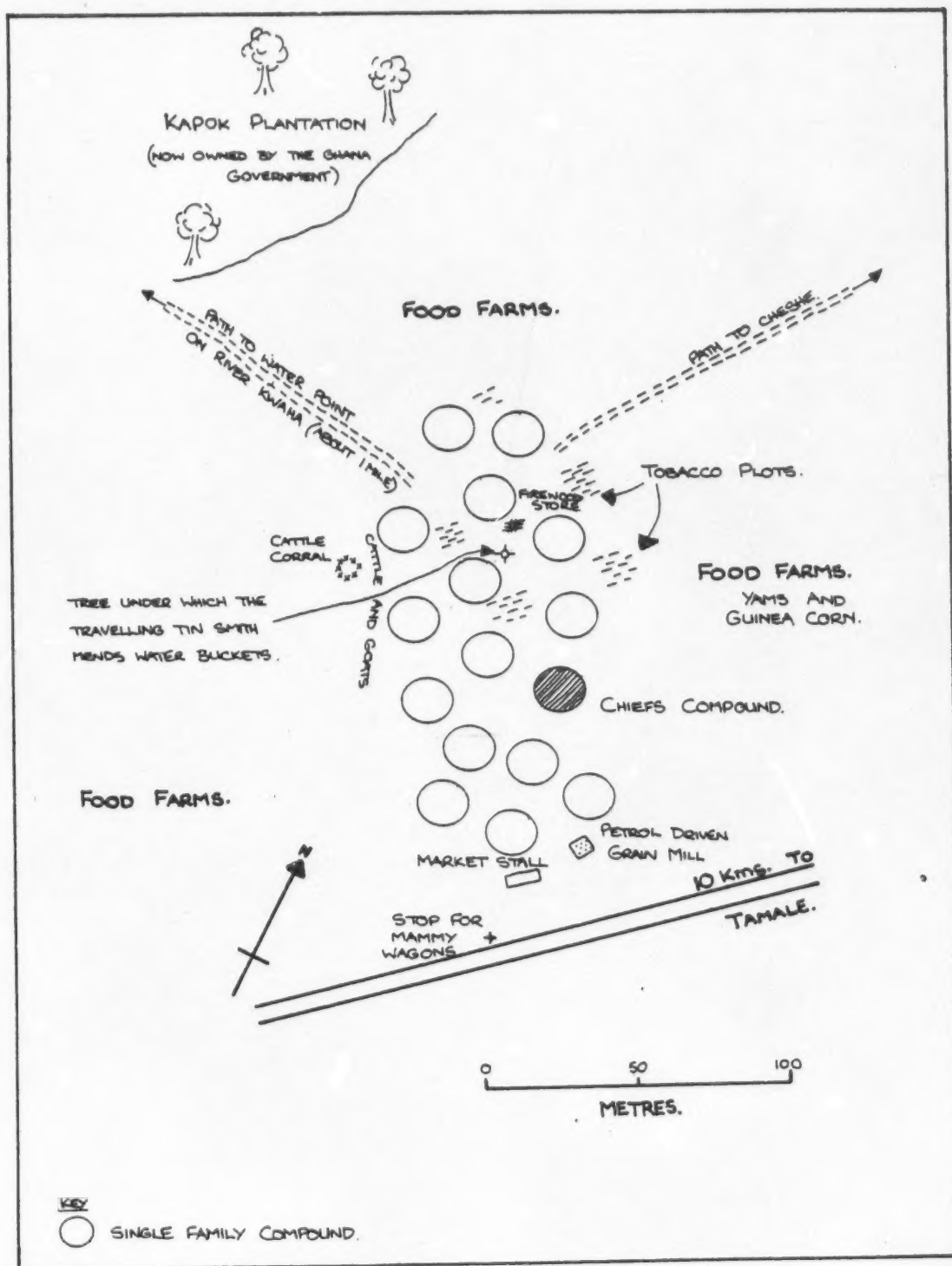


Round hut with conical roof.

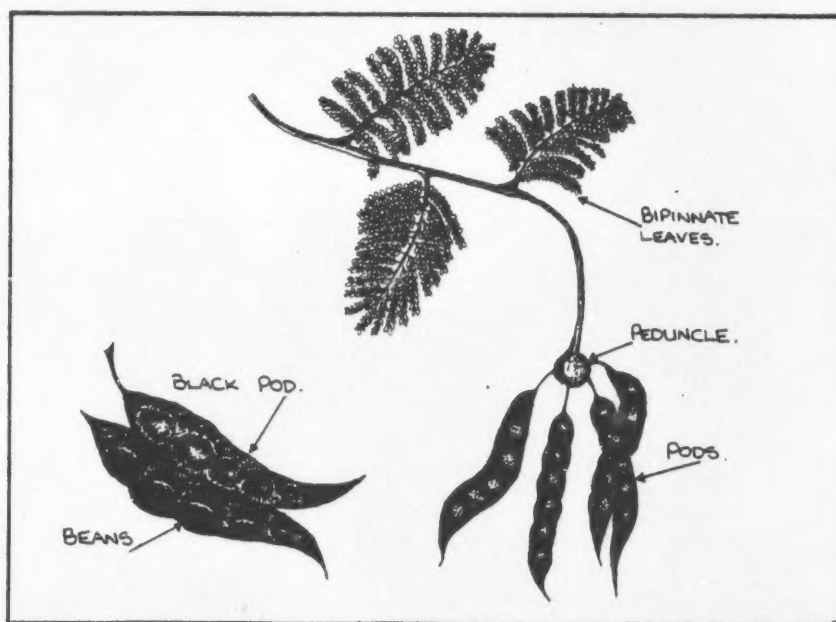
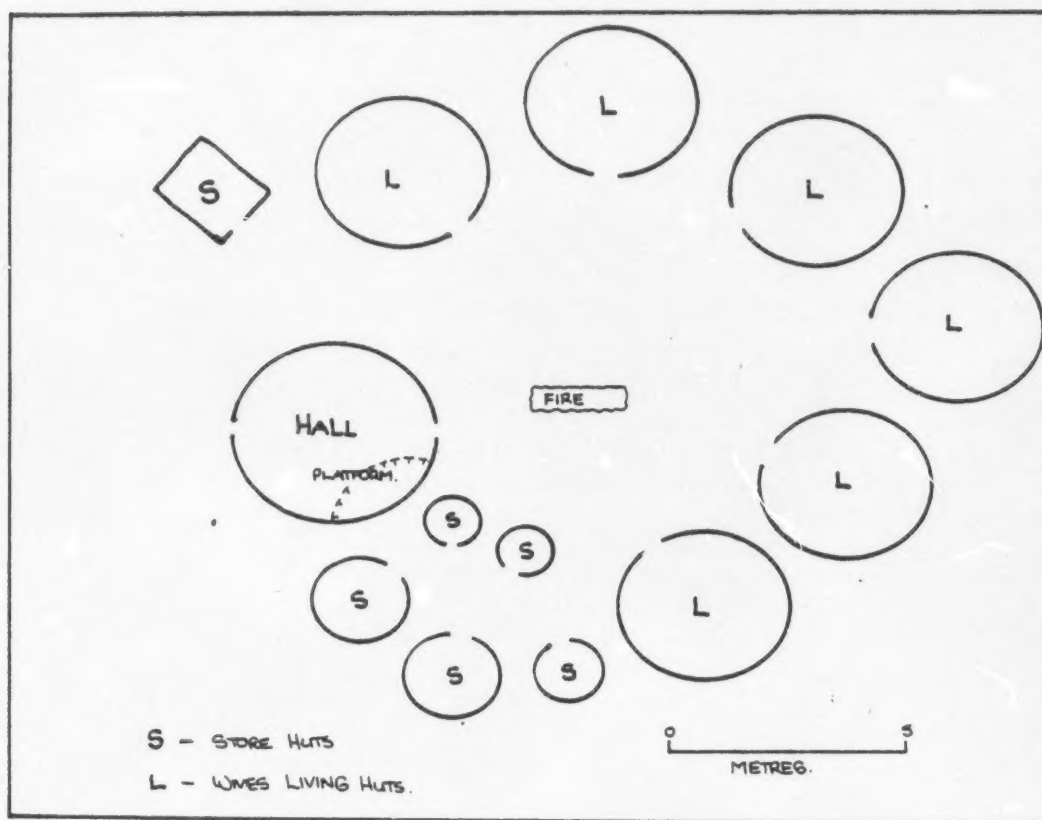
The village consists of sixteen compounds which appear scattered. Although it is a nucleated settlement there is no market area or important building making a central point in the village. The chief's compound is not centrally placed. (See plan of Datoyili village).

A compound is composed of a small group of huts, usually between six and ten, linked together by a common wall 5'-6' high. Each compound is owned by a single polygamous family. Permission to settle and build a compound is

PLAN OF DATOYILI VILLAGE



CHIEF'S COMPOUND, DATOYILI



Leaves and pods of the Dua tree.

given by the chief and he indicates where the building may take place. A compound is built by the family as there are no specialised building craftsmen. Building methods are handed down to each generation, (see plan of Chief's Compound and drawing). The circular walls are made of sticky clay or mud built up layer by layer. The mud, or "swish", dries to form a very hard brick-like material. The walls have no internal framework to give reinforcement. The roof has a framework of radial rafters which are set into the top of the mud walls. On these rafters the roof is built up in a series of layers of the thatch made up of guinea corn stalks, giving a fairly steeply angled conical roof. The ante-chamber because of its size needs greater support for the roof and therefore has four posts with cross beams. The ante-chamber has two doorways. The outer doorway has a decoration of broken china surrounding it, mostly various sized pieces of plates. These are set into a very smooth plaster of mud so that the decoration is slightly raised above the general surface of the hut. (See drawing).

Building and repair take place in the dry season. Unless they are maintained annually the huts will only last four or five years.

The interior of the huts is dark and cool, the only light coming through the doorway. The interior walls are plastered with mud and pointed with a dye extracted from the pod or fruit of the 'dua' tree. (See diagram). This dye is painted on to the inside of mud huts to act as a repellent against cockroaches, ants and other insects - preventing them from settling on the walls or in any cracks which might appear. The floors are of smooth hardened clay. There is no electricity in the village. Lighting is provided by the use of hurricane lamps and by burning wick in oil.

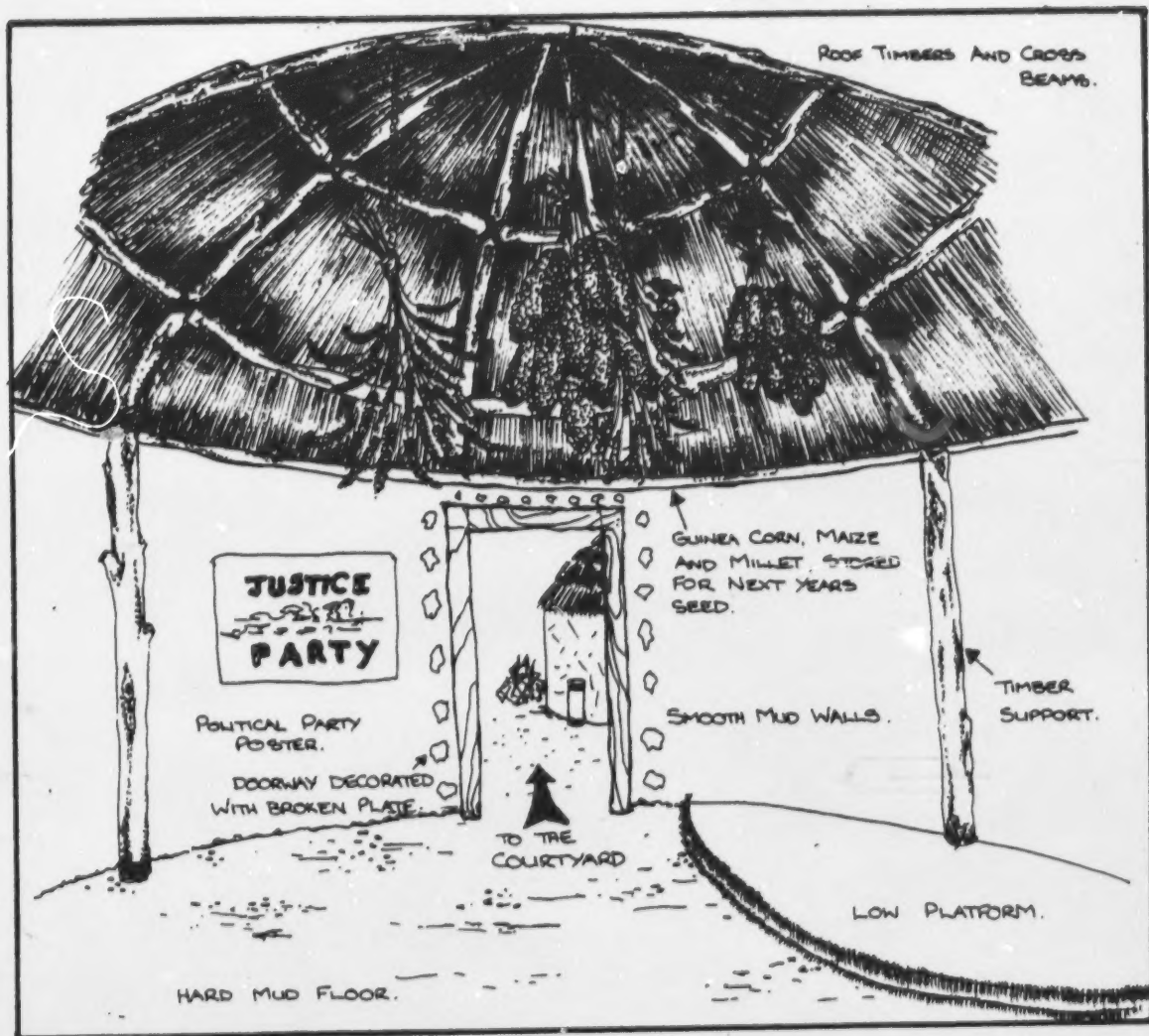
The outside walls can be plastered with makuba (empty pods of the locust bean tree pounded and dissolved in water) to make them more resistant to rain. Sometimes cow dung is mixed with mud to form a paste for plastering the exterior of the hut. This plaster is a poor conductor of heat and so will decrease the rate at which the interior heats up and adds to the overall effect of keeping the interior cool.

The chief's compound is taken here as being typical of compounds in general. It is oval in shape and consists of a large hall, 5 huts for his wives and 6 storage huts. Linked together by a wall, the building forms a single unit with one gap to allow entry into the courtyard of the compound. (See Drawing).

The large hut is the hall and ante-chamber used by the chief. Inside is a small slightly raised area on which animal skins are laid. The chief

INTERIOR OF CHIEF'S HUT -

DATOYILI



sits here when consulting with his elders and villagers. (The number of skins indicates the wealth and power of the chief). The only furniture is one stool and some woven baskets which are placed against the wall. Hanging from the rafters is an inverted calabash (gourd) with eight bundles of grain crops - guinea corn, some of which is the dwarf, high yielding variety, maize and millet stoned for next year's seed. (See drawing of interior of Chief's hut).

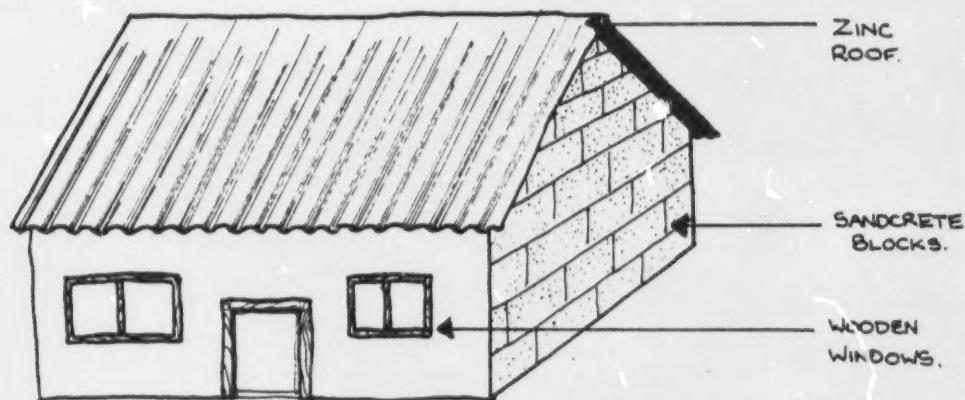
The five small huts belong to the chief's wives; each wife has her own hut. If, however, the chief takes more wives, the fifth wife will live with the first wife, the sixth with the second wife etc. (The number of wives too reflects the wealth of the chief). These huts have small doorways; furnishings are also simple. Some pots contain food; other clay pots and calabashes are piled neatly against the walls. The remaining six huts are for storing food.

In the central courtyard is a communal fireplace on which all food is cooked.

Outside the compound but within the village are a few conical bins made of woven baskets with removable thatch lids in which more grain is stored.

In town areas most of the houses are rectangular in shape, made from concrete or sandcrete bricks and the roof is usually corrugated iron or aluminium sheets, to conform to European fashion.

RECTANGULAR HUT.



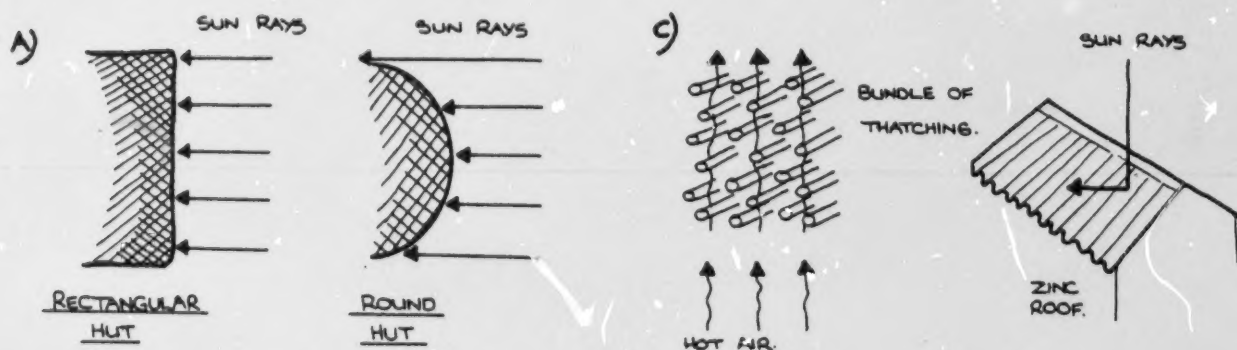
Advantages of Round Houses

1. The cylindrical nature of the rooms reduce the heat of the sun's rays. Direct rays coming from the sun do not strike the cylindrical room perpendicularly, but at an angle. Since direct rays are absorbed more than oblique rays, the rooms are comparatively cooler than expected.

2. The thatched roof is a non-conductor of heat, therefore does not transmit heat into the room.
3. The rooms do not have windows, but ventilation takes place. The thatched roof is not a solid piece, but porous. Since hot air rises and cold air falls, the hot air escapes through the roof, while cool air from outside enters the room through the door.
4. During the day the rooms are cooler since little heat gets into them, nor can the hot air from outside get in as the cool air inside will not allow it.

Which House is Cooler to Live in?

- a) The rectangular walls will often be presenting a flat surface perpendicular to the sun's rays, whilst the round hut will always offer an oblique surface to the sun's rays. The greater the area covered, the smaller is the intensity



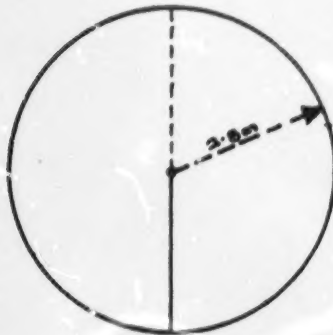
on any one point. An experiment could be designed to illustrate this by shining a beam of light onto cardboard models. This could be developed further using a heat source.

- b) Mud is a slower conductor of heat and this will slow down the rate at which the interior heats up. Does concrete conduct heat more easily than mud? The outer walls of the traditional round hut are usually plastered with a solution of cow dung which is baked to a very hard finish in the hot sun, this layer protects against erosion in the rainstorms and also is a very poor conductor of heat and adds to the overall effect of keeping the interior cool. The lack of windows ensures that the interior is always shaded, there is little direct sunlight in the room.
- c) Hot air rises and this is able to pass up through the thatching and this acts as a ventilator, also the thatching is a bad conductor of heat. The shiny zinc roof will reflect a lot of the sun's rays but a lot of heat will be transmitted into the room. Also ventilation will be poor. The roof eventually rusts and its ability to reflect sun's rays is diminished.

Which Shape is More Convenient?

How much material (mud bricks) is needed to build the walls of each design? Given the information below and if the walls are 2.5 m. high in both cases, calculate the respective surface areas. If the mud blocks are 25 x 10 x 10 cms. how many would you need in each case?

Round Hut



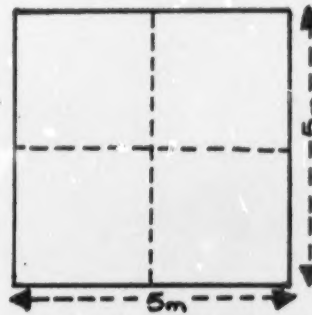
$$\text{Area} = \pi r^2 = 24.64\text{m}^2$$

(For calculation assume area = 25m^2)

Radius = 2.8m.

Height of wall = 2.5m.

Rectangular Hut



$$\text{Area} = 25\text{m}^2$$

Length of wall = 5m.

Height of walls = 2.5m.

CALCULATE

Circumference of round hut ($2\pi r$)

Surface area of walls

Number of mud bricks needed

Which hut is cheaper to build?

Which shape is better suited to accommodate a bed measuring 2m x 0.5m?

Which house is easier to build?

CALCULATE

Perimeter of rectangular hut

Surface area of walls

Number of mud bricks needed

There are basically three different ways of thatching, depending on the shape of the hut:

CONICAL



HEMISPHERICAL

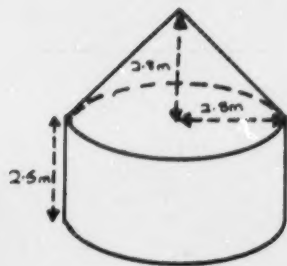


RECTANGULAR

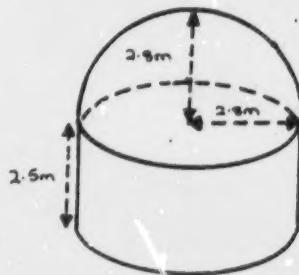


COMPARISON OF ROOF AREAS

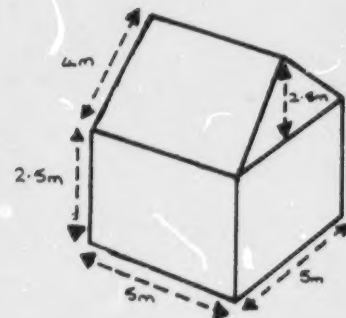
CONICAL



HEMISPHERICAL



RECTANGULAR



Area of Cone = $\pi r l$ ($\pi = \frac{22}{7}$) Area of Hemisphere = $2\pi r^2$
 (r = radius)
 (l = length)
 sloping side)

Area of Sloping Sides

Which Roof is Cheapest to Build?

Is the rectangular roof cheaper to build than the hemispherical roof?

What about the gable ends of the rectangular house?

Which roof is easiest to thatch with broad leaves, such as palm leaves and why?

What kind of rectangular hut gives the maximum amount of floor area?

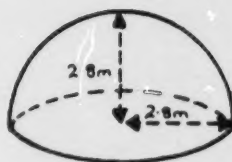
COMPARISON OF THE INTERNAL VOLUMES OF THE ROOFS

CONICAL



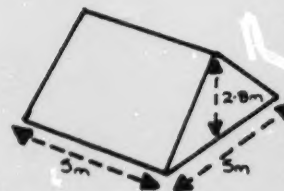
$$\text{Volume of cone} = \frac{1}{3}\pi r h$$

HEMISPHERICAL



$$\text{Volume of hemisphere} = \frac{2}{3}\pi r^2$$

RECTANGULAR



$$\text{Volume} = \text{Area of triangle} \left(\frac{1}{2} \text{ base} \times \text{height} \right) \times \text{length}$$

Which shape gives the most volume?

Which shape gives the best volume per m^2 of thatch?

Which shaped roof gives the best value for money?

Contribution from Mumbi Partick and Mwansa Lanes from Lubushi Seminary in
Northern Zambia

Traditional House

It started mainly among the African people to make their life well. They invented this kind of house and it really made their life easier in the way they were living.

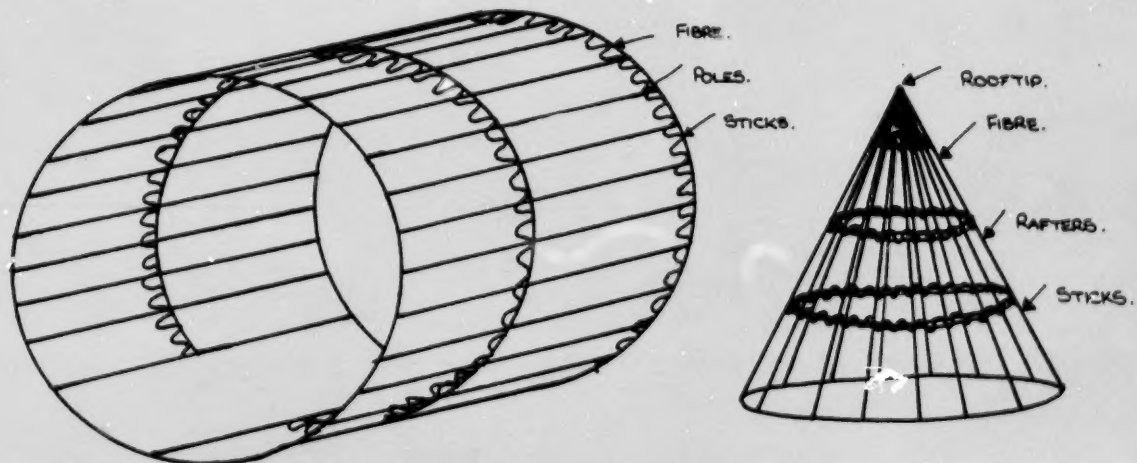
Materials

An axe, a hoe, grass - especially finger grass, fibres, rafters, poles and little sticks.

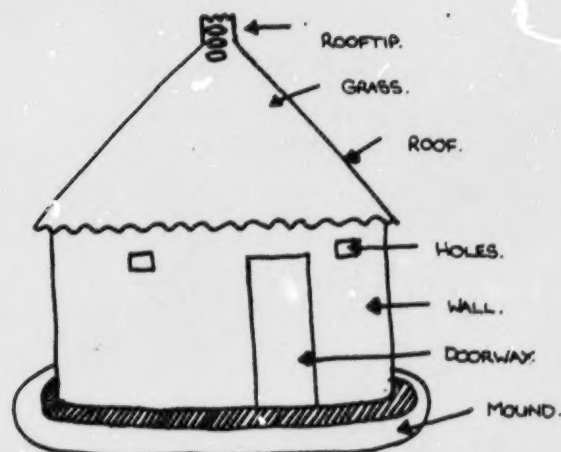
Method

The people of long ago, they were building a traditional house in the form of a cylinder but not high and small, but this time some are building them in the form of a square. Maybe they have copied from the white men who built their houses in bricks in a form of a square.

The very first thing to start to a traditional house is to collect the fibres, poles, rafters, little sticks and finger grass. After that, you can choose a suitable place and make a big mound where a house could stand. It can be at least 50 cm. high and you can mark around on it smoothly where you can stand the poles. And now you can tie the poles with small sticks, this makes the house strong especially the wall. The poles of the house should come from hard trees like Mubanga, Ndale, Kaimbe etc to resist the ants and pests which penetrate into them. The little sticks also must come from stiff trees which can easily bend when we are tying them together with the poles and the rafters. The roof of the house is made up of rafters and little sticks. The rafters are sharpened ends meet together at the roof-tip and we tie them with small sticks to make the roof strong. The traditional house looks like this before it is thatched and covered with mud.



When you have covered the pole with mud now it called a wall. The roof is thatched with a special grass called finger grass which prevents water or rain to enter in the house. In addition to this, the roof being made in the form of one isosceles triangle it prevents rain water from entering in the house through the roof. After these, the complete traditional house will be able to look like the following diagram.



The floor of the traditional house is levelled with the soil from the anthills and this must be painted with white and black soil. The door of the traditional house is made up of grass or seeds. It is the last thing to be made. It is used to cover on the doorway which has got two posts especially at night to prevent cold and harmful things from entering the house.

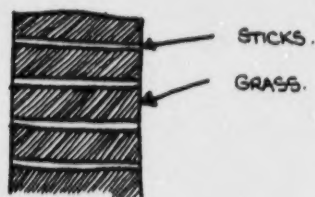


Diagram of the door. The door made of reeds is stronger than the one made of grass.

Holes

The holes in the traditional house are for ventilation to purify the air inside the house. Ventilation can be natural or artificial. Artificial ventilation is used by bars, stores, hospitals, hotels, but to the traditional house, it is natural ventilation which occurs.

Purposes of Ventilation

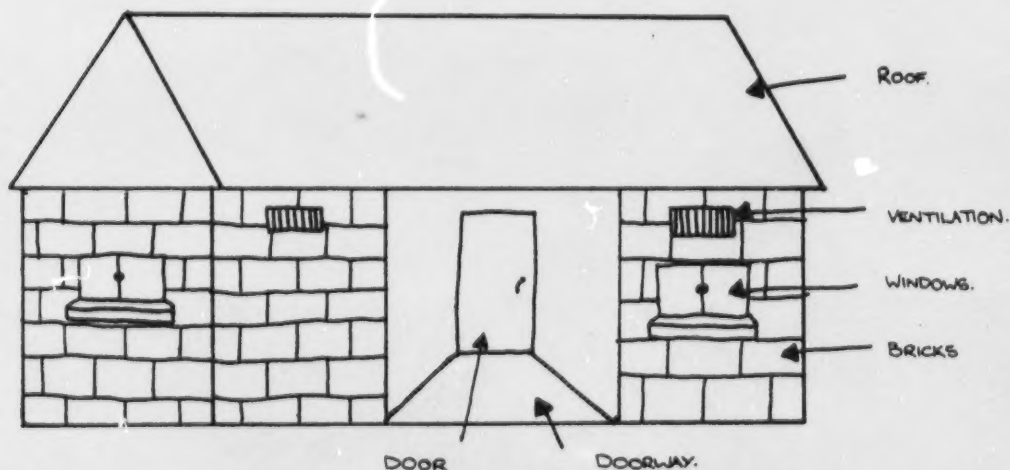
- a) To remove the waste products burning and breathing from the house and be replaced by pure air.
- b) When gas is heated it expands so hot air rises up and cool from the outside comes and replace hot air in the house. The air we breathe out is dirty and far lighter than pure air because it is warm. The dirty air in the room rises up and finds its own way through the holes on the wall and cool air comes in.

If we compare a traditional house to a modern house, there is a big contrast. The traditional house can have one or two small rooms, whereas a modern house can have many rooms and the formation is very different. The traditional house is thatched with grass while the modern house is covered with iron or asbestos and the wall is made of bricks or rocks, while to the traditional house it is mud and poles. The rooms of the modern house can be supplied with window panes for ventilation sometimes, it is artificial ventilation sometimes, it is artificial ventilation by using electric fans. The air may be forced into the room and bad air sucked out of the room through the tubes near the roof. Modern house can be painted with paint and lime and also a traditional house, but after they use white or black soil.

A modern house is very important in this country. It can be built in bricks or rocks, the materials which are required are mould, window panes, glasses, paint, lime, iron or asbestos and capital.

Method

The very first thing to start is to make bricks, you burn them to make them strong. The next thing is to choose a suitable place where to build it, and make foundation at least 50cm. deep and then you start building. After finishing, you plaster it with cement and paint it with lime and paint. The roof is hammered with iron nails to make it strong. The door is made up of planks and windows all left on the wall.



Advantages of Modern House

1. It is strong
2. It can last long
3. doesn't easily damage
4. It looks more attractive than a traditional house
5. Modern houses are bigger

Advantages of Traditional House

1. Easy to build
2. Not expensive
3. It is cool inside

Disadvantages

- a) Too expensive
- b) It is difficult to build
- c) It is hot inside especially the iron type

Disadvantages

- a) It doesn't last long
- b) It is small
- c) Dusty inside
- d) It can be easily damaged by rain, ants, fire.

Traditional House (Imitanda)

It is mainly built by those people who migrate in the bush to be near their families in various times e.g.- harvesting, growing crops. They do this to reduce the distance from their villages to the fields.

Materials

Grass, poles, rafters, fibres.

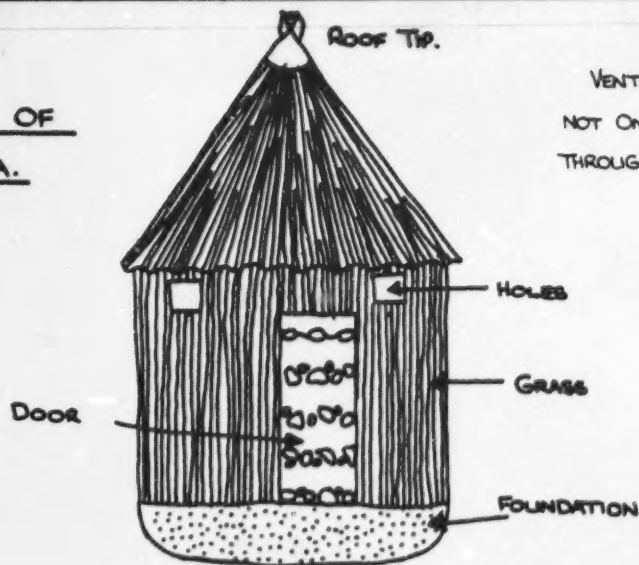
Method

Imitanda is the most primitive jerry built house. We can call Mitanda as the house of grass because it is what it is like when it is finished.

The very first thing is to collect the material we have mentioned in the last notes. After you have gathered these, you can cover it with grass and bury the foundation with the soil. The formation of the roof of mitanda is made in the same way like the traditional house, and also the roof.

Imitanda is dangerous at night and in the day time because snakes can penetrate in the grass and enter the house. In addition to this dangerous animals enter the house by breaking mutanda. In the doorway of imitanda there are two strong door posts they are used to close the door, the floor of mitanda house is cleaned with a hoe.

DIAGRAM OF
MUTANDA.



VENTILATION IN THE MUTANDA OCCURS
NOT ONLY THROUGH THE HOLES, BUT ALSO
THROUGH THE GRASS WALLS AND ROOF.

The door of imitanda is the same as in the traditional house. It is made of grass, reeds and little sticks. When one compares mitanda to the traditional house and modern house, we find that mitanda is a jerry built house, and primitive than of the two.

Advantages of Mitanda

- a) It is easy to build and it doesn't require too much energy.
- b) It can be built in a short time.
- c) People doesn't go a long distance to work in their fields.
- d) It is not expensive.

Disadvantages

- a) It can be easily damaged by fire, rain.
- b) Snakes can enter the mutanda through the grass.
- c) It is not defensive.
- d) It is small.
- e) It doesn't last long. It is only used for a few months.

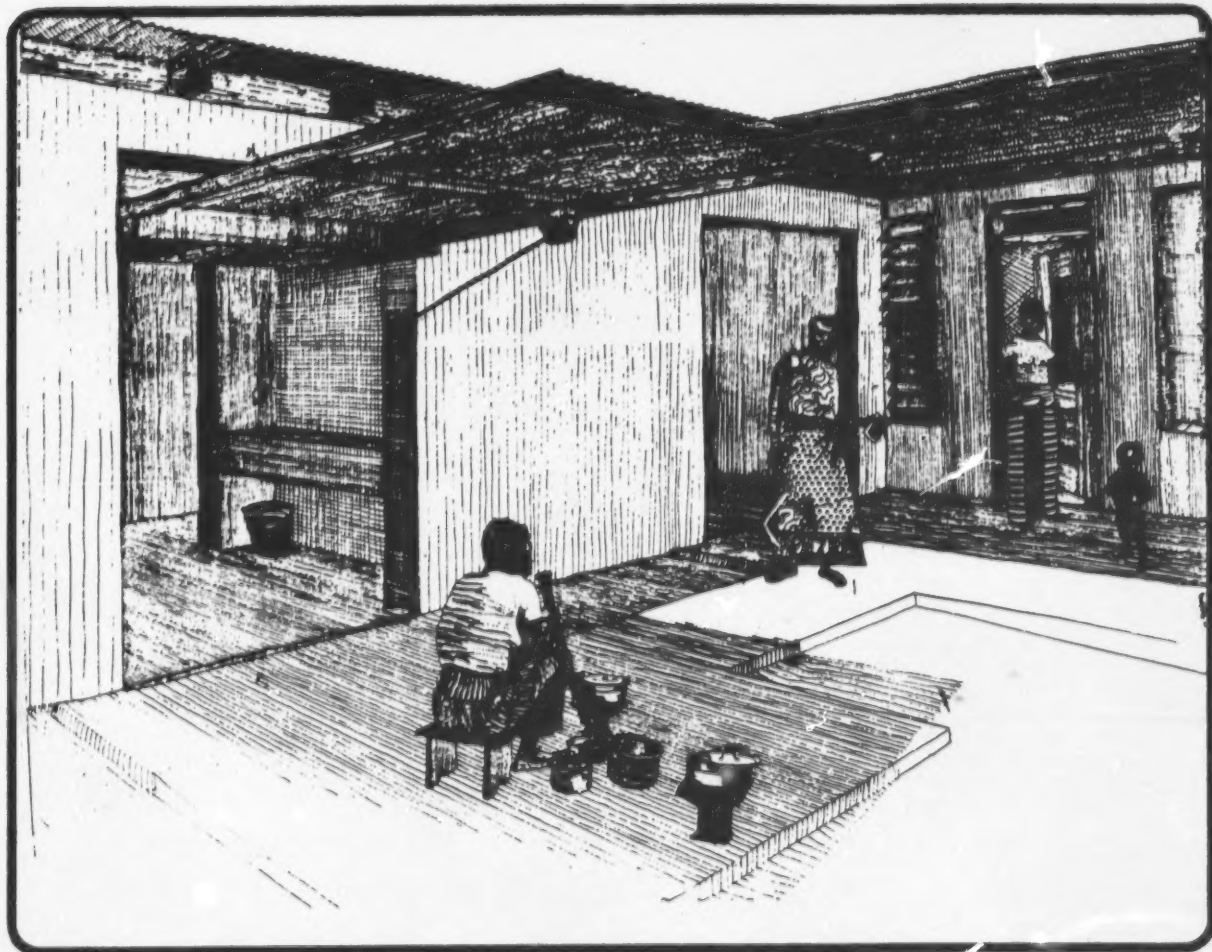
Appropriate Building Technology

The drawing below shows a type of 'intermediate technology' housing proposed in the early 1970's for Tema, Ghana. Tema is an industrial township built over the last twenty years.

The housing unit is a core of one room, a kitchen store, shower, toilet and wash basin with mains drainage and water supply. The basic unit can be expanded by adding up to four rooms around the courtyard.

The sketch shows the kitchen store (far left), containing a double sink, opening onto a courtyard (centre). The large up-and-over door provides shade for the mother while she cooks. She sits on her stool in the courtyard surrounded by food, charcoal pots and cooking utensils.

Materials from nearby are used to build the house. The blocks are made in the Tema blockyard with Ghanaian sand and cement. The roof and cladding to the kitchen shutter are of corrugated aluminium sheeting, which is finished locally. The timber used in the joinery and roof structure is second grade African hard-wood.



The ceilings of the house are made of planed softwood boards. These are salvaged from packing cases. Most of the locks and fastening devices are made by local blacksmiths.

Housing like this fits in with how families are arranged and with how people in Tema are used to living. The design was made after talking with people about what they needed and wanted in a 'house'. It is important that housing makes the best value of local materials and local labour - and also be the sort of place in which people want to live.

Intermediate Building Technology - Project in Sri Lanka

Very little research has been carried out by the developing countries themselves to improve indigenous building techniques and materials. Furthermore, few of the research results have been applied in practice, nor communicated to neighbouring countries although they may share common building problems.

With these considerations in mind, the Commonwealth Science Council initiated a project to 'transfer the technology' of improved rural housing methods to villages in South East Asia. The Overseas Division of the U.K. Building Research Establishment (BRE) was invited to take part in the project, and to collaborate with the Sri Lanka State Engineering Corporation (SEC) in its initial stages.

SRI LANKA (previously called Ceylon) is an island lying in the Indian Ocean off the southern tip of India between latitudes 6° and 10° north of the Equator. In its area it is about half the size of England, covering some 63,330 square kilometres, with no point in the country being more than 125 kilometres from the sea. The greater part of the island is low-lying and flat except for the south central provinces or up-country covered by mountains with peaks rising to nearly 1,600 metres.

The field work took place between February 8 and March 1 1980, the driest months of the year in Sri Lanka. Because many of the villages are in remote areas it was necessary to call upon the assistance of district officers to identify and give the location of typical villages in their district.

One significant feature of all the villages was the lack of main services available. No electricity was available for cooking or lighting, the villagers having to rely on wood fuel or oil lamps for these purposes. With exception of only a few villages served by water wells the remaining villages obtained their water from local streams or rivers.

Whenever possible each settlement was located near to or amongst clusters of palm trees or beside hills to afford as much protection as possible from wind.

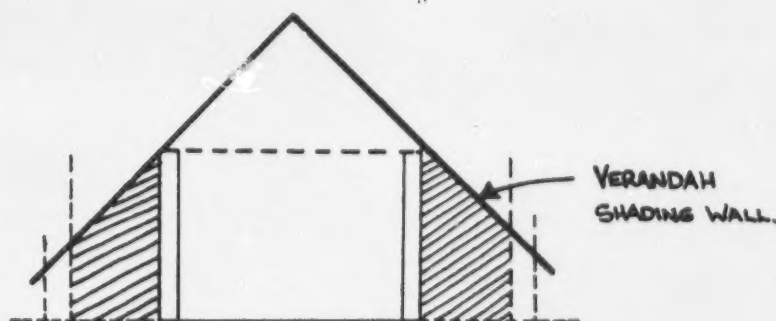
The great majority of house types were single storey detached bungalows usually containing more than one room, though not always. In only one house, a better middle class house, was a staircase found leading to a loft.

One common feature of the houses studied was the existence of verandahs along one or more of their sides, and with roofs which were integral part of the house roof.

Verandahs played an important role in daily domestic living in that they provided a seated and shaded area for general recreation and social gatherings. One other important function was to provide an area for the preparation of food by the housewife. Courtyards, defined by low walls were not seen.

The majority of houses were located on plots of land for growing some food, and were defined in the main by wire fencing or palmyra fencing.

The most popular type of roof covering was found to be cadjan (a woven matting made from coconut palm leaves) and rice straw thatch. The survey indicates that both cadjan and thatch have approximately similar durabilities and need to be replaced at 3 year intervals. More frequent replacement than this was due to low roof pitch resulting in poor rain run off.



Not surprisingly fired clay tiles were recorded as providing the most durable roof covering and some owners of cadjan or thatch roofed houses expressed a desire to re-cover with tiles.

Hipped roofs were the most common shape to be found, with two-way pitched roofs coming a close second. The most steeply inclined hipped roof may possibly extend their life due to good rain run off.

The most common walling material in Sri Lanka is soil in the form of wattle and daub. This acts as an infill rather than a load bearing wall.

All the houses in this survey were built on trench foundations filled with rubble or consolidated earth. Further stability of wattle and daub houses was achieved by burying the roof support posts and secondary uprights in the ground.

In the case of wattle and daub houses it might be expected that sensible criteria for good foundation practice are: treatment with a preservative such as coal tar or sump oil of the structural uprights especially below ground level; and to ensure that each upright is buried sufficiently deep to resist

high wind loads especially in cyclones. From discussions with villagers it transpired that these criteria were not always followed and that there was the possibility of failure of the uprights at ground level during adverse weather due to wood rot and insect damage.

Glazed windows were by no means a common feature of traditional village housing; instead, in those houses which had windows, wooden shutters were often used.

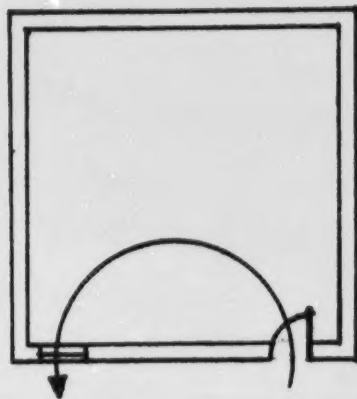
The majority were fitted with doors in their external openings and were usually made from plywood, or roughly nailed planks of wood.

The only source of ventilation in some rooms was through a door or window opening in one wall which meant that very little or no air movement was noticeable. Another factor causing poor ventilation was a result of the necessarily large overhangs, the eaves of which, in some cases were extremely near ground level.

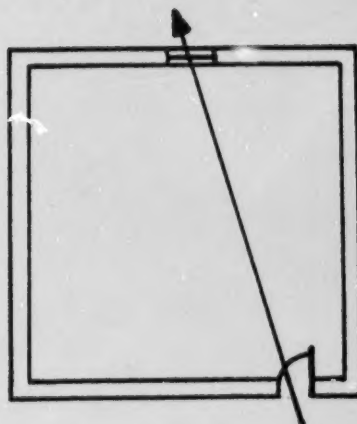
A few owners were seen to have attempted to improve ventilation or provide an alternative means of air movement, possibly when window shutters or doors were closed, by introducing vent holes at lintel height. Other vent holes were seen to be located near ground level so as to induce air movement by convection. (See Diagrams)

Poor lighting was a common feature of many traditional houses. Large overhangs needed for shade and protection were a contributory factor. Artificial lighting was achieved from candles or paraffin lamps.

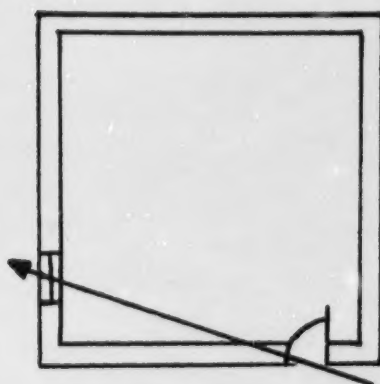
The survey has shown up a few deficiencies in the traditional housing, and if these items could be improved without resorting to expensive technology and materials it would be possible to make substantial improvements to the overall quality of housing. The best approach depends on local materials, climate, skills and the use for which the building is intended.



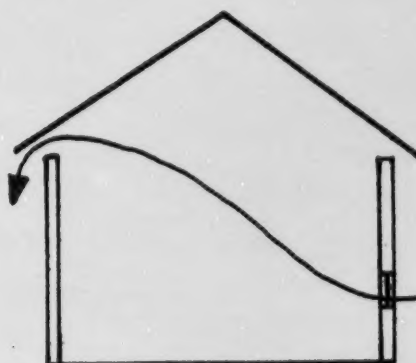
1. LITTLE AIR MOVEMENT.



2. CROSS VENTILATION.



3. SIDE VENTILATION.



4. CONVECTION.

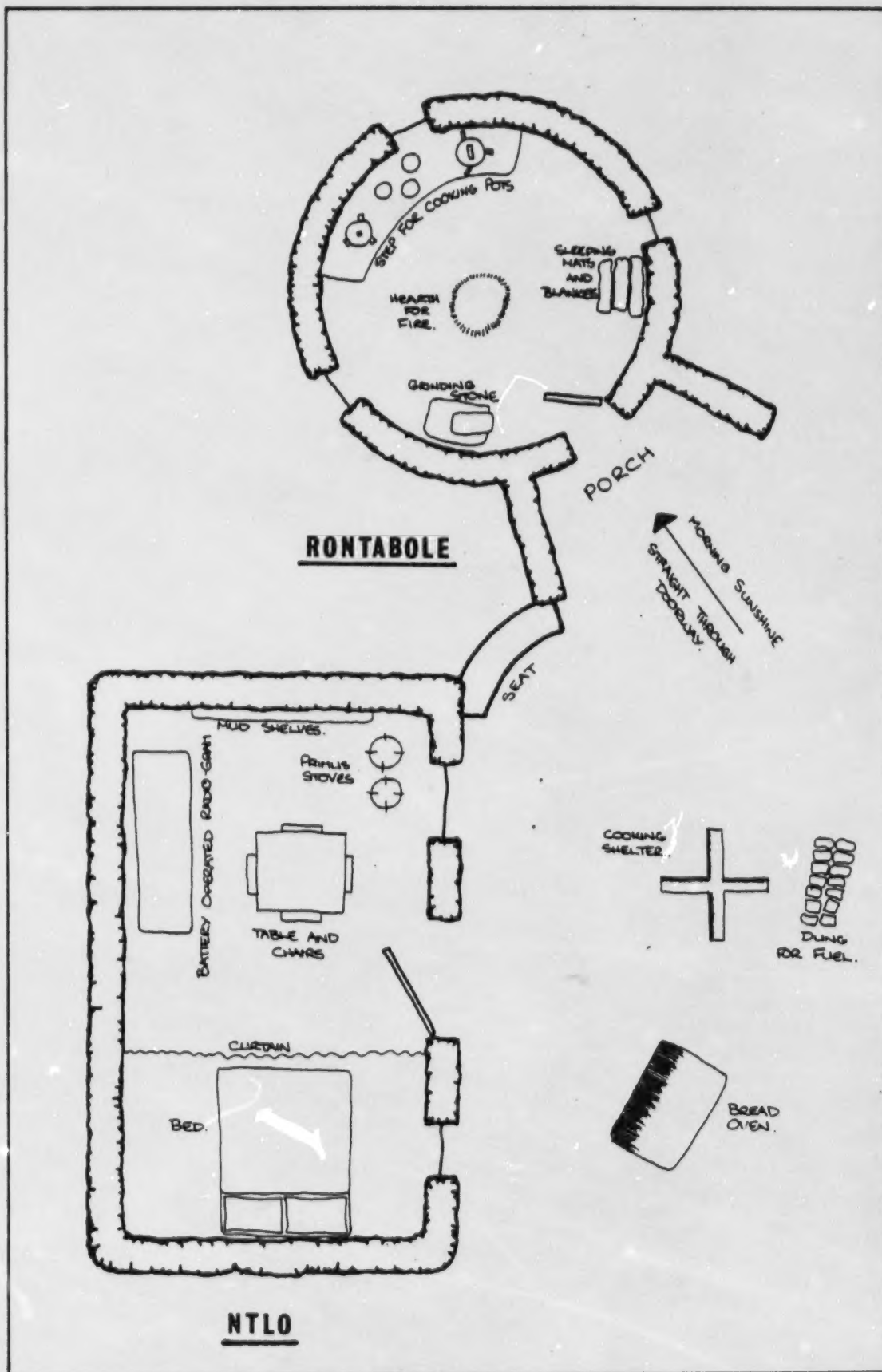
WAYS OF IMPROVING VENTILATION.

Pupil Activities
Two Models to Make

The traditional means of building relies on self-help and the co-operation of the family. A family had all its own skills such as masonry, thatching and smearing and did not need to employ anyone. All the materials were available locally, their collection relating to the agricultural seasons, so that skills developed and were handed down from one generation to the next. This system has been disrupted by the introduction of money from the migrant labour system and the desire to emulate the white man, so creating a demand for factory-made components. House building, as a result, becoming a costly operation with people in the village becoming specialist masons, thatchers etc, (but not smearers, as this is the job of women, who do not migrate). Therefore all possible combinations of the two model houses, traditional and modern, are to be found in most villages.

The skills of the village people are not always adequate to cope with the new materials. For example, the rontabole roof, because of its conical shape, does not blow off in the wind; however, the flat roof is easily sucked off unless tied down adequately to the walls. In a strong gale, many houses have their roofs torn off and blown through the air for some hundreds of yards. The rontabole wall(see diagram), because of its curve, is very strong, and does not require great skill in bonding the stonework. You can demonstrate this by standing a piece of paper on edge, first straight and then in a curve. By placing your hand on top you will find the curved paper takes a much greater load before it fails. The straight wall of the ntlo (see diagram) is rarely properly bonded and therefore often falls down in places, even before the roof is on. There is a great need to develop the village skills to cope with modern materials and construction.

The rontabole is a pleasant and comfortable house to live in. It is cool in summer and warm in winter because of its thick mud walls and thatched roof. The mud floor is warmer to the feet than a carpet. Doors and windows always face the rising sun, as dawn is the coldest time of day. The afternoon sun is hot and uncomfortable. The old houses have a very small shuttered window facing the setting sun and giving a little cross-ventilation in the house. In the new design of the house, this feature is often forgotten, so that excessive heat, built up from the iron roof, cannot escape. The ntlo as a result is too hot in summer and very cold in winter. Families do not have the money to fit ceilings or insulation for the iron sheets are very expensive.



The ntlo has one feature that is an improvement over the rontabole. It is not struck by lightning. The thatched conical roof is especially susceptible to lightning strike after a long dry spell. Why?

Traditional work, even in Britain, is usually labour-intensive. Imagine collecting the grass and reeds for the roof. It is necessary to cut the reeds standing in the water, where there may be snakes. The river may be a 5-hour round walk, there and back, with one bundle of reeds each time. A largish rontabole requires about 20 bundles of reeds. A woman can carry up to 3 bundles of grass but about 100 are required. So she needs help from other people. Corrugated iron sheets are usually delivered by the trader only along the main gravel road. People then carry the sheets on their heads. Sometimes many kilometres, to their building sites. Imagine how a large roof sheet could be caught by the wind and twist the carrier around!

Materials, such as grass, are allocated to the people by the chief, rather as we once had rights on the village common land. The people have the right to these materials in exchange for a duty to the chief. This does not involve any payment in money, so with the co-operation of the extended family, every member of a chief's village can build a house in which to live. The introduction of money as a payment for work and materials, and the absence of the men has changed this. House building has become an expensive affair and has to be paid for solely by the breadwinners of the family. In addition, as people get the idea that they can sell their labour for money, they become less interested to help their family members build their own houses. The old are now often unable to repair their own houses and do not have the money to pay anyone to do it. As materials such as grass can be sold for money now, they will do this to buy food rather than repair their own roofs. So the extended family is breaking down into small units similar to Britain.

The village is located in barren land overlooking the fertile valley so that good agricultural land is not lost. It is also convenient to a spring for drinking water on the mountain side.

Tools used in the house construction are few and simple. The mason has no spirit level, relying on his eye for line and level. He can build a perfect curved wall this way, with a slight lean inwards which gives it great beauty. His tools are simply a heavy hammer and a trowel. The thatcher too needs a good eye to give the roof a neat appearance. His tools are a wooden block to tamp down the grass and a big needle, made from a split aloe pole, 1.2 metres or more long, with which to thread the string to tie down the thatch. The women do the smearing, using hands or some sharp object.

All the houses of the model village will be a little different from each other; that is how it is in a real village.

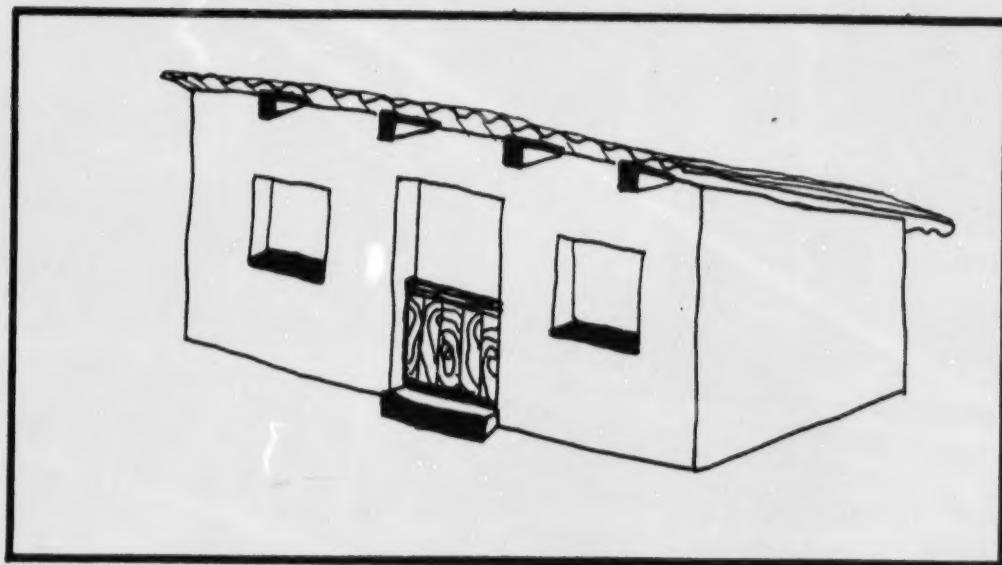
To build each house you will require:

- a ball of clay/plasticene, about the size of a large fist
- 3 pipe cleaners
- 4 drinking straws
- some fairly thin string and glue
- grass (or raffia) and thread (a sewing machine is best)
- paper, and corrugated card
- powder paints
- a knife to cut the clay
- scissors and a sharp pencil

(See illustrated instruction guide)



HOW TO MAKE MODELS OF
A RONTABOLE
AND
A NTLO



1. A RONTABOLE.

1.



The people build walls of stone or sunbaked bricks bedded in soil. MAKE YOUR MODEL OUT OF CLAY OR PLASTICENE, ABOUT 10 TO 15 cms IN DIAMETER. THE WALLS MUST BE 1 TO 1½ cms THICK WITH A SLIGHT LEAN INWARDS.

2.



Originally windows and doors were simple shutters and grass or skin curtains. Timber and glass are now commonly used.

TRIM THE TOP OF THE MODEL STRAIGHT AND LEVEL. CUT THE DOORS AND WINDOWS.

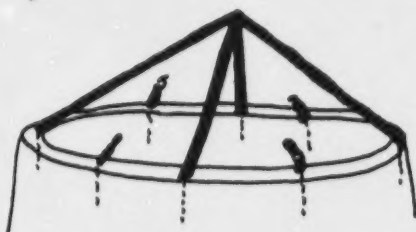
The windows are usually small and square.

3.

The weight of the roof holds it on the walls.

YOU MUST INSERT SHORT LENGTHS OF PIPE CLEANER AT THE END OF EACH POLE TO KEEP THEM IN PLACE.

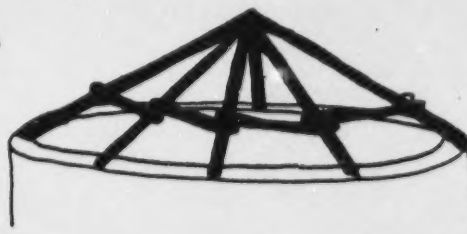
4.



The roof poles are cut from the flower stalk of the aloe which grows up to 25 feet tall in a single season. Like bamboo they are very strong.

USE DRINKING STRAWS, CUT TO ABOUT ¾ OF THE HOUSE DIAMETER, AND JOIN AT THE TOP [4 POLES ONLY] WITH PIPECLEANERS.

5.



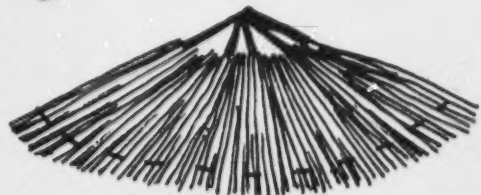
A real house has 16 or more roof poles which must form a neat peak or the roof will leak.

YOUR MODEL HAS ONLY 8 POLES.

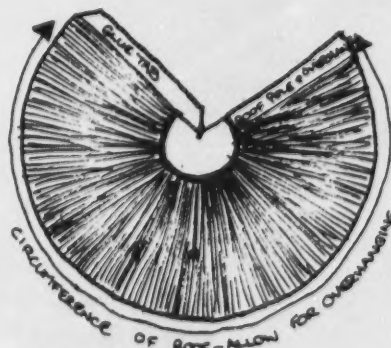
Laths are made of split aloe into which the thatch is tied.

USE STRING

6.



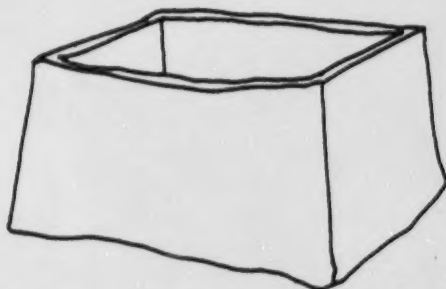
River reeds are first laid over the laths. YOU CAN USE GRASS [OR RAFFIA] STITCHED TOGETHER ALONG ONE SIDE THEN LAID OVER THE ROOF. ALLOW A GOOD ½ cm OVERHANG TO THE WALLS.



Grass is laid over reeds to make a warm and waterproof roof. CUT OUT A PAPER CONE DRAWING LINES FOR THE GRASS.

2. A NTLO.

1.



Sometimes the walls are built of concrete blocks made by hand at the river.

BUILD THE WALLS OF YOUR MODEL OF CLAY OR PLASTICENE, ABOUT 18 x 12 cms AND ABOUT 1 TO 1½ cms THICK.

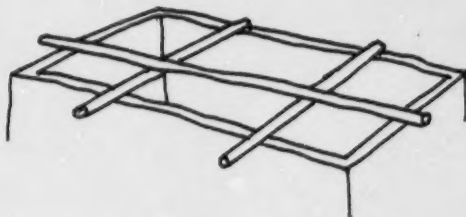
2.



Doors and windows are made of steel or timber imported into Lesotho. The windows are larger than the traditional house.

TRIM THE WALLS OF YOUR MODEL TO GIVE THE ROOF A SLOPE FROM FRONT TO BACK. CUT OUT THE WINDOWS AND THE DOOR.

3.



Roof-timbers are of sawn pine [imported - Lesotho has no trees] and roof sheets are corrugated iron [also imported].

USE DRINKING STRAWS FOR THE TIMBERS, SET INTO THE CLAY, AND CORRUGATED CARDBOARD FOR THE ROOF SHEETS.

References

1. Town and Village in Northern Ghana - some useful slides on different types of buildings. (C.W.D.E.)
2. Intermediate Technology Slides - No. 6. Building. (C.W.D.E.)
3. Science Teacher (London Vol. 20. No. 1 & 2, 1976, pp. 10-13 - Influence of Culture on Learning and Teaching of Science in Northern Ghana. J.M. Yakubu.
4. Commonwealth Institute - topic No. 11. Two Savanna Villages in Northern Ghana.
5. Oxfam topic booklet - Lesotho.
6. Intermediate Technology Leaflet - Housing.
7. Commonwealth Science Council - Regional Rural Technology Programme - A survey of Village Housing in Sri Lanka.

ACKNOWLEDGEMENTS

The Third World Science Project has been supported by a number of agencies and has drawn upon the expertise and goodwill of a vast number of individuals.

Pilot Project 1979-80 supported by the Overseas Development Fund

Writers: Trevor Roach, Philip Bladon Typing: Carole Johns
Graphics: George Robinson

Main Project 1981-82 supported by the Manpower Services Commission

Writers: Natalie Jones, Wyn Hughes Typing: Marjorie Eccles
Graphics: Karen Moss

In this phase of the project 100 sets of 14 Units have been produced and distributed to schools, teachers' centres and teacher training establishments. Draft material has been prepared for further Units.

Dissemination 1982-3 supported by the University of Wales

Faculty of Education Research and Publications Fund

Printing: University College of North Wales Print Unit

Distribution: The Centre for World Development Education,
Buckingham Palace Road, London SW1W 9SH

The continued support and encouragement of Mr Dick Meakins of the CWDE is gratefully acknowledged

Sources The ideas and information incorporated in these Units come mainly from science teachers who are, or have been, teaching abroad. In some cases their pupils have also contributed. Some are known to us personally, others only through their letters, articles and books. We are very grateful to them all.

Wherever possible authors of published material and copyright holders have been approached for permission to reproduce extracts from their work. Where it has been impossible to trace the authors, apologies are offered.

For further information please contact

Professor Iolo Wyn Williams
Third World Science Project
School of Education
University College of North Wales
BANGOR, Gwynedd, U.K.

Copyright: Third World Science Project 1982

